भारतीय मानक
Indian Standard

IS 16190 : 2014
(Reaffirmed 2018)

कृषि वस्त्रादि — सिंचाई के लिए उच्च घनत्व पालीइथाईलीन (एच.डी.पी.ई.) लैमिनेटेड बुनी ले फ्लैट ट्यूब — विशिष्टि

Agro Textiles — High Density Polyethylene (HDPE) Laminated Woven Lay Flat Tube for Irrigation Purpose — Specification

ICS 59.080.40

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भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली–110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.org.in www.standardsbis.in

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Technical Textiles for Agro-tech Sectional Committee, TXD 35

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Technical Textiles for Agro-tech Sectional Committee had been approved by the Textile Division Council.

Transportation of the water from ponds, canal or borewell to the various part of the field for agriculture is of paramount importance. High density polyethylene laminated woven lay flat tube has been developed to easily transport water in the agriculture field and have an advantage of lighter in weight. These lay flat tubes do not require fixed installation and can transport water at the place of choice easily. Farmers are expected to incur less fixed expenditure to irrigate their field at considerably lower running cost as compare to the existing piping systems. These lay flat tubes can sustain the actual field conditions like uneven field surface, extreme climatic conditions, resistance to puncture etc.

The composition of the Committee responsible for the formulation of this standard is given in Annex F.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

AGRO TEXTILES — HIGH DENSITY POLYETHYLENE (HDPE) LAMINATED WOVEN LAY FLAT TUBE FOR IRRIGATION PURPOSE — SPECIFICATION

1 SCOPE

This standard prescribes constructional and other requirements for high density polyethylene (HDPE) laminated woven lay flat tube for irrigation purpose. These lay flat tubes are used at the delivery lines of the agriculture pump sets, which may be exposed to atmosphere and sunlight.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex. A.

3 TERMINOLOGY

For the purpose of this standard the following definition shall apply.

3.1 LLDPE — It is a co or terpolymer of ethylene produced by catalytic polymerization of ethylene with other l-alkenes having density in the range of 908.4 to 938.4 kg/m^3 at 27°C (910 to 940 kg/m^3 at 23°C).

4 MATERIALS

4.1 HDPE Tapes

Tapes shall be manufactured from HDPE granules (*see* IS 6192), which shall be UV stabilized by adding suitable UV stabilizer. The width of the tape used in the fabric shall be 2.50 mm minimum and linear density of the tape shall be 77.7 Tex (700 Denier) minimum.

4.2 HDPE Fabric

Lay flat tube shall be manufactured from HDPE woven fabric conforming to variety No. 2 of IS 6899. The HDPE woven fabric shall have a minimum of 39 tapes/dm in warp and weft direction.

5 MANUFACTURE

5.1 Lamination

The fabric shall be laminated with the low density polyethylene (LDPE) or suitable combination of LDPE and linear low density polyethylene (LLDPE) melt of coating grade on each side and the coating shall be UV stabilized by incorporating UV stabilizer.

5.2 A 5 layer laminated fabric is produced using a combination of 2 layers of HDPE fabric and 3 layers of coating film. The minimum coating thickness shall be 35 µ. The layers of HDPE fabric used to manufacture lay flat tubes, shall be joined by sandwich lamination. The minimum thickness of the sandwich lamination shall be 40 µ.

5.3 The laminated HDPE woven fabric is to be formed in to lay flat tube of the required inside diameter using a heat sealing process keeping the minimum overlap as specified in Table 1.

6 REQUIREMENTS

The laminated HDPE woven fabric used to manufacture lay flat tube shall meet the requirements given in Table 2.

6.1 Internal Diameter

The inside diameter of the lay flat tube shall be as given in Table 1. The internal diameter of the lay flat tube

Table 1 Internal Diameter and Tolerance and Minimum Overlap of Lay Flat Tubes
(*Clauses* 5.3 *and* 6.1)

Sl No. (1)	Nominal Internal Diameter mm (2)	Tolerance on Nominal Bore mm (3)	Overlap *Min* mm (4)
i)	50	$^{+2.5}_{-0}$	30
ii)	63	$^{+2.5}_{-0}$	30
iii)	75	$^{+3.5}_{-0}$	30
iv)	110	$^{+3.5}_{-0}$	30
v)	125	$^{+3.5}_{-0}$	30
vi)	150	$^{+3.5}_{-0}$	30
vii)	175	$^{+4}_{-0}$	30
viii)	200	$^{+4}_{-0}$	30

Table 2 Requirements of HDPE Woven Laminated Fabric

(*Clause* 6)

Sl No. (1)	Characteristic (2)	Requirement(s) (3)	Method of Test, Ref to Annex (4)	Method of Test, Ref to IS No. (5)
i)	Mass, g/m², *Min*	260	—	IS 1964
ii)	Breaking strength before UV exposure, N, *Min*	1 200 (Warp) 900 (Weft)	—	IS 1969 (Part 1)
iii)	Elongation at break, percent	20 ± 5	—	IS 1969 (Part 1)
iv)	Retention of breaking strength after UV exposure of 500 h, N, *Min*	85 percent of original actual value (fabric)	B	—
v)	Abrasion resistance	Loss in breaking strength shall not be more than 15 percent	—	IS 14714
vi)	Trapezoid tear strength, N, *Min*	100 (Warp) 100 (Weft)	—	IS 14293
vii)	Puncture strength, N, *Min*	300	C	—
viii)	Environmental stress cracking test	There shall be no evidence of stress cracking	D	—
ix)	Accelerated ageing test for 72 h at 70 ± 1°C	Loss in breaking strength shall not be more than 1 percent	—	IS 7016 (Part 8) (Oven method)
x)	Cold cracking resistance test at –5°C	No specimen shall damage or broken	E	—

shall be measured by a suitable conical plug gauge and shall conform to the tolerance specified in Table 1.

6.2 Workmanship

The lay flat tube shall be free from dirt, knots, lumps, irregularities of the tape and other visible defects.

6.3 Hydrostatic Burst Pressure Test

A test length of lay flat tube, one metre clear of fittings when subjected to an internal hydraulic pressure shall not burst before a pressure of 2.6 kg/cm^2 is reached.

6.3.1 *Procedure*

Connect the test specimen to the hydraulic pressure line and completely fill with water by bleeding all air from the free end of the hose through a petcock or valve. The hydrostatic pressure shall be applied at a uniform rate of increase by means of a hand pump, hydraulic pump or accumulator. Raise the pressure to the minimum required burst pressure in not less than 15 s and not more than 30 s. Inspect the lay flat tube during pressurization and record the maximum pressure reached.

6.4 Proof Pressure Test

The lay flat tube when subjected to an internal hydraulic pressure of 1.3 kg/cm^2 shall not develop any leakage or sweating nor any thread in the jacket shall break.

6.4.1 *Procedure*

Connect the test specimen to the hydraulic pressure line and completely fill with water by bleeding all air from the free end of the hose through a petcock or valve. The hydrostatic pressure shall be applied at a uniform rate of increase by means of a hand pump, hydraulic pump or accumulator. Raise the pressure to the proof pressure in not less than 15 s and not more than 30 s. Maintain the proof pressure in the lay flat tube for about 5 min and thoroughly inspect the lay flat tube, while at the specified proof pressure.

6.5 Length

Unless specified otherwise, the standard length shall be 30 m. A tolerance of +5 percent shall be permitted on the length prescribed for the lay flat tube by the purchaser. No negative tolerance shall be permitted.

6.6 Kink Test

Connect a 3 m length of lay flat tube to a suitable hydraulic pump. Blank the free end of lay flat tube with a suitable coupling having arrangement to bleed out entrapped air with the help of suitable stop cock or pet cock. Fill the lay flat tube with water and raise the pressure to 30 kPa (0.3 kgf/cm^2). Allow all air to escape through stop cock by raising the free end of the lay flat tube and again rebuild the pressure to 30 kPa. Now kink the lay flat tube through 180°at approximately 50 cm from the free end by tying the lay flat tube back against itself as close to the fitting as practicable. Increase the pressure to 0.6 kg/cm^2 in not less than 15 s and not more than 30 s. When maximum pressure has been attained, retain it for 30 seconds, release the pressure, examine it for sign of leakage and damage. There shall be no sign of leakage or rupture and no thread in the jacket shall break.

6.7 Welded Seam Strength Before UV Exposure

When a sample of fabric with seam cut from the lay flat tube is tested for welded seam strength as per the method specified in IS 1969 (Part 1), welded seam strength before UV exposure shall be not less than the 80 percent of the original actual fabric strength.

6.8 Welded Seam Strength After UV Exposure

When a sample of fabric with seam cut from the lay flat tube is tested for welded seam strength as per the method specified in Annex B and IS 1969 (Part 1), the loss in welded seam strength after UV exposure shall be not more than 15 percent.

7 MARKING

7.1 Each bundle of lay flat tube shall be legibly marked with the following information at one corner on one side either with tag or by printing on it with the ink:

a) Name and address of the manufacturer;
b) Nominal bore;
c) Length, in m; and
d) Month and year of manufacture.

7.2 BIS Certification Marking

The lay flat tube may also be marked with the Standard Mark.

7.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and Rules and Regulations made thereunder. The details of the conditions under which a license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

8 PACKING

The lay flat tubes shall be packed as agreed to between the buyer and the seller.

9 SAMPLING

9.1 Lot

All lay flat tube rolls of same nominal internal diameter manufactured under similar conditions and delivered to a buyer against one dispatch note shall constitute a lot.

9.2 Unless otherwise agreed to between the buyer and the seller, the number of lay flat tube rolls to be selected at random from a lot shall be as given in col 3 of Table 3.

10 NUMBER OF TEST SPECIMENS AND CRITERIA FOR CONFORMITY

Number of test specimens and criteria for conformity shall be as given in Table 4.

Table 3 Scale of Sampling
(*Clause* 9.2)

Sl No. (1)	No. of Rolls in Lot (2)	Sample Size (3)	Sub-Sample Size (4)	Permissible No. of Defective Rolls (5)
i)	Up to 50	3	2	0
ii)	51-150	5	2	0
iii)	151-300	8	3	1
iv)	301-500	13	5	2
v)	501 and above	20	5	3

Table 4 Number of Test Specimens and Criteria for Conformity
(*Clause* 10)

Sl No. (1)	Characteristic (2)	No. of Rolls/ Test Specimens (3)	Criteria for Conformity (4)
i)	Internal diameter, overlap, workmanship, length, manufacture and material	According to col 3 of Table 3	The defective rolls do not exceed the corresponding number given in col 5 of Table 3
ii)	All other requirements	According to col 4 of Table 3	All the test specimens shall pass the tests

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
1964 : 2001	Textiles — Methods for determination of mass per unit length and mass per area of fabrics (*second revision*)
1969 (Part 1) : 2009	Textiles —Tensile properties of fabrics — Determination of maximum force and elongation at maximum force : Part 1 Strip method (*third revision*)
2454 : 1985	Methods for determination of colour fastness of textile materials to artificial light (Xenon lamp) (*first revision*)
6192 : 1994	Textiles- Monoaxially oriented high density polyethylene tapes — Specification (*second revision*)
6899 : 1997	Textiles — High density polyethylene (HDPE) woven fabrics — Specification
6359 : 1971	Method for conditioning of textiles
7016 (Part 8) : 1975	Methods of test for coated and treated fabrics: Part 8 Accelerated ageing
14293 : 1995	Geotextiles — Method of test for trapezoid tearing strength
14714 : 1999	Geotextiles — Determination of abrasion resistance

ANNEX B

[*Table* 2, *Sl No.* (iv) *and clause* 6.8]

UV RESISTANCE TEST

B-1 PRINCIPLE

Specimens of fabric used for manufacturing lay flat tube for the machine and cross directions are exposed for 500 h of ultraviolet exposure in a Xenon-arc apparatus. The exposure consists of 120 min cycles consisting of 102 min of light only, followed by 18 min of water spray and light. After the exposure, the specimens are subjected to a cut strip tensile test as prescribed in IS 1969 (Part 1). The test results are compared to the test results for unexposed specimens and the deterioration which has taken place due to ultraviolet exposure is assessed.

B-2 ATMOSPHERIC CONDITIONS FOR CONDITIONING AND TESTING

Condition the test specimens to moisture equilibrium from the dry side in the standard atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C temperature (*see also* IS 6359). When the specimens have been left in such an atmosphere so that both the faces are exposed to the standard atmosphere as far as possible for 24 h, they shall be deemed to have reached the state of moisture equilibrium.

B-3 PREPARATION OF TEST SPECIMENS

B-3.1 Cut 5 test specimens from each of the machines and the cross directions from the test pieces.

B-3.2 Specimens shall not contain dirt, irregular spots, creases, holes or other visible faults.

B-3.3 Any two specimens shall not contain the same longitudinal or transversal position. If it is not possible, it shall be reported.

B-4 APPARATUS

B-4.1 The working details of Xenon-arc apparatus are described in IS 2454.

B-4.1.1 The apparatus should be capable of exposing the specimens to cycles of light only, followed by water spray and light under controlled atmospheric conditions.

B-4.1.2 The apparatus should be equipped with an inner and outer borosilicate filter glass as described in IS 2454.

B-4.2 Tensile strength testing machine as described for cut strip test in IS 1969 (Part 1).

B-5 PROCEDURE

B-5.1 Operate the Xenon-arc apparatus as directed in IS 2454 to provide 120 min cycles as follows:

102 min of light only at 65 ± 5°C black panel temperature, and 30 ± 5 percent relative humidity, followed by 18 min of light and water spray.

B-5.1.1 Set the minimum level of radiation to 0.5 W/m^2, 1 nm bandpass at 340 nm.

B-5.2 Randomly expose five specimens for each direction for 500 h exposure time. Place 10 specimens (5 for each direction) in the apparatus, such that the side most likely to be exposed to the effects of ultraviolet light shall be exposed in the apparatus.

B-5.3 At the end of exposure time, remove the test specimens for tensile test using cut strip test as given in IS 1969 (Part 1).

B-5.4 Test five unexposed specimens (zero exposure time) and five exposed specimens for each direction for breaking strength on a constant-rate-of-extension (CRE) or a constant rate-of-traverse (CRT) type testing machine by cut strip test, as given in IS 1969 (Part 1). In case of controversy, the CRE method shall prevail.

NOTE — A specimen of 50 mm width at a gauge length 75 ± 1 mm shall be used. If tested on a CRT machine, the traverse speed shall be 300 ± 15 mm/min.

B-6 CALCULATIONS

B-6.1 Calculate the average breaking strength in N for all exposed and unexposed specimens for each direction.

B-6.2 Calculate the percent loss of strength for the unexposed specimens for the average results for each direction.

ANNEX C

[*Table* 2, *Sl No.* (vii)]

TEST METHOD FOR INDEX PUNCTURE RESISTANCE

C-1 SCOPE

This test method is used to measure the index puncture resistance of fabric used for manufacturing lay flat tubes.

C-2 PRINCIPLE

A test specimen is clamped without tension between circular plates of a ring clamp attachment secured in a tensile testing machine. A force is exerted against the centre of the unsupported portion of the test specimen by a solid steel rod attached to the load indicator until rupture of the specimen occurs. The maximum force recorded is the value of puncture resistance of the specimen.

C-3 APPARATUS

C-3.1 Tensile/Compression Testing Machine, of the constant-rate-of extension (CRE) type.

C-3.2 Ring Clamp Attachment, consisting of concentric plates with an open internal diameter of 45 ± 0.025 mm capable of clamping the test specimen without slippage. A suggested clamping arrangement is shown in Fig. 1. The external diameter is suggested to be 100 ± 0.025 mm. The diameter of the six holes used for securing the ring clamp assembly is suggested to be 8 mm and equally spaced at a radius of 37 mm. The surfaces of these plates can consist of grooves with a-rings or coarse sandpaper bonded onto opposing surfaces.

C-3.3 Solid Steel Rod, with a diameter of 8 ± 0.01 mm having a flat end with a 45° × 0.8 mm chamfered edge contacting the test specimen's surface (*see* Fig. 1 and Fig. 2).

C-4 TEST SPECIMEN

The test specimens shall be cut from the HDPE woven laminated fabric and shall have a minimum diameter of 100 mm to facilitate clamping. If the 100 mm diameter sample is not available, smaller diameter may be taken provided sample is properly clamped.

C-5 Conditioning

Bring the specimens to moisture equilibrium in the atmosphere for testing (65 ± 5 percent relative humidity and 27 ± 2^{o}C temperature). Equilibrium is considered to have been reached when the increase in the mass of the specimen, in successive weightings made at intervals of not less than 2 h, does not exceed 0.1 percent of the mass of the specimen.

C-6 PROCEDURE

C-6.1 Select the load range of the tensile/compression testing machine such that the rupture occurs between 10 and 90 percent of the full-scale load.

C-6.2 Centre and secure the specimen between the holding plates ensuring that the test specimen extends to or beyond the outer edges of the clamping plates.

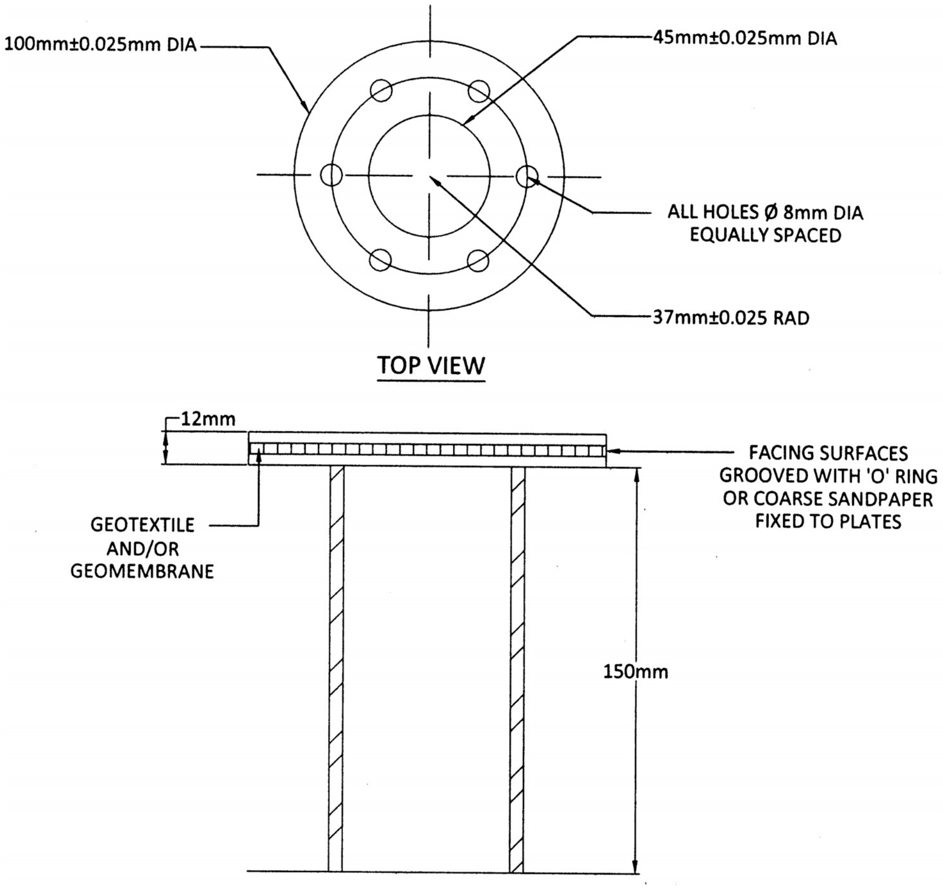

FIG. 1 TEST FIXTURE DETAIL (NOTE TO SCALE)

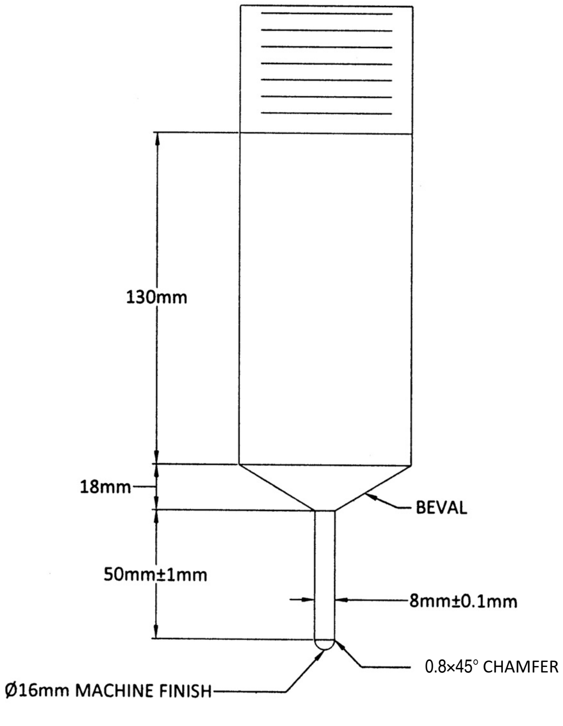

FIG. 2 TEST PROBE DETAIL (NOTE TO SCALE)

C-6.3 Test at a machine speed of 300 ± 10 mm/min until the puncture rod completely ruptures the test specimen.

NOTE — The rate of testing specified is not an indication of the performance of the specimen for its end use.

C-7 CALCULATION

Calculate the average puncture resistance and standard deviation for all tests as read directly from the recording instrument.

ANNEX D

[*Table* 2, *Sl No.* (viii)]

METHOD OF TEST FOR RESISTANCE TO ENVIRONMENTAL STRESS CRACKING

D-1 APPARATUS

An air oven controlled at 60 ± 2°C.

D-2 TEST LIQUID

A 0.5 percent aqueous solution of polyoxyethylated nonylphenol.

NOTE — Teepol B 300 has been found suitable.

D-3 TEST SPECIMEN

The test specimens shall be cut from the HDPE woven laminated fabric and shall have a length of 150 ± 3mm and width of 50 ± 3mm.

D-4 PROCEDURE

The test specimen shall be dipped in the test liquid contained in a beaker at 27 ± 2°C. The beaker along with test specimen shall be kept in the oven at 60 ± 2°C for 48 h. The test specimen shall then be inspected for cracks, the test specimen being sectioned, where necessary.

ANNEX E

[*Table* 2, *Sl No.* (x)]

METHOD FOR DETERMINATION OF COLD-CRACK RESISTANCE TEST

E-1 PRINCIPLES

Specimens bowed in the shape of a loop are placed in a cooling chamber at –5°C and subjected to sudden folding under the impact of a free-falling mass of 500 g. The test specimen shall not break or is damaged.

E-2 APPARATUS

The following description is an example of a typical test apparatus design (*see* Fig. 3).

E-2.1 Impact device, comprising the following elements.

E-2.1.1 *Specimen Holder*, permitting the fastening of one or more specimens on a platen by means of clamps (e.g. leaf springs) to clench each specimen along its entire width (15 mm) and to secure 10 mm of each end of the loop (*see* Fig. 3) so that the length of the loop section subjected to folding is 40 mm.

The platen may be equipped with a mechanism (revolving type) that allows each specimen to be placed successively in the test position under the guide tube which guides the impact mass.

E-2.1.2 *Rigid Anvil*, connected to, or part of, the specimen holder and on which the specimen is brought into the test position.

E-2.1.3 *Impact Mass*, 500 g, consisting of metal cylinders with a diameter of not less than 18 mm and not more than 29 mm, the edge of the lower face being slightly rounded.

E-2.1.4 *Guide Tube*, to guide the impact mass equipped at the upper end with a mechanism to release the mass (solenoid or mechanical trigger).

This tube, approximately 250 mm long and with a diameter 1 mm larger than that of the impact mass, shall be placed vertically above the specimen test position and shall be mounted so that the drop height, that is the distance between the base of the impact mass and the anvil, is 200 ± 2 mm.

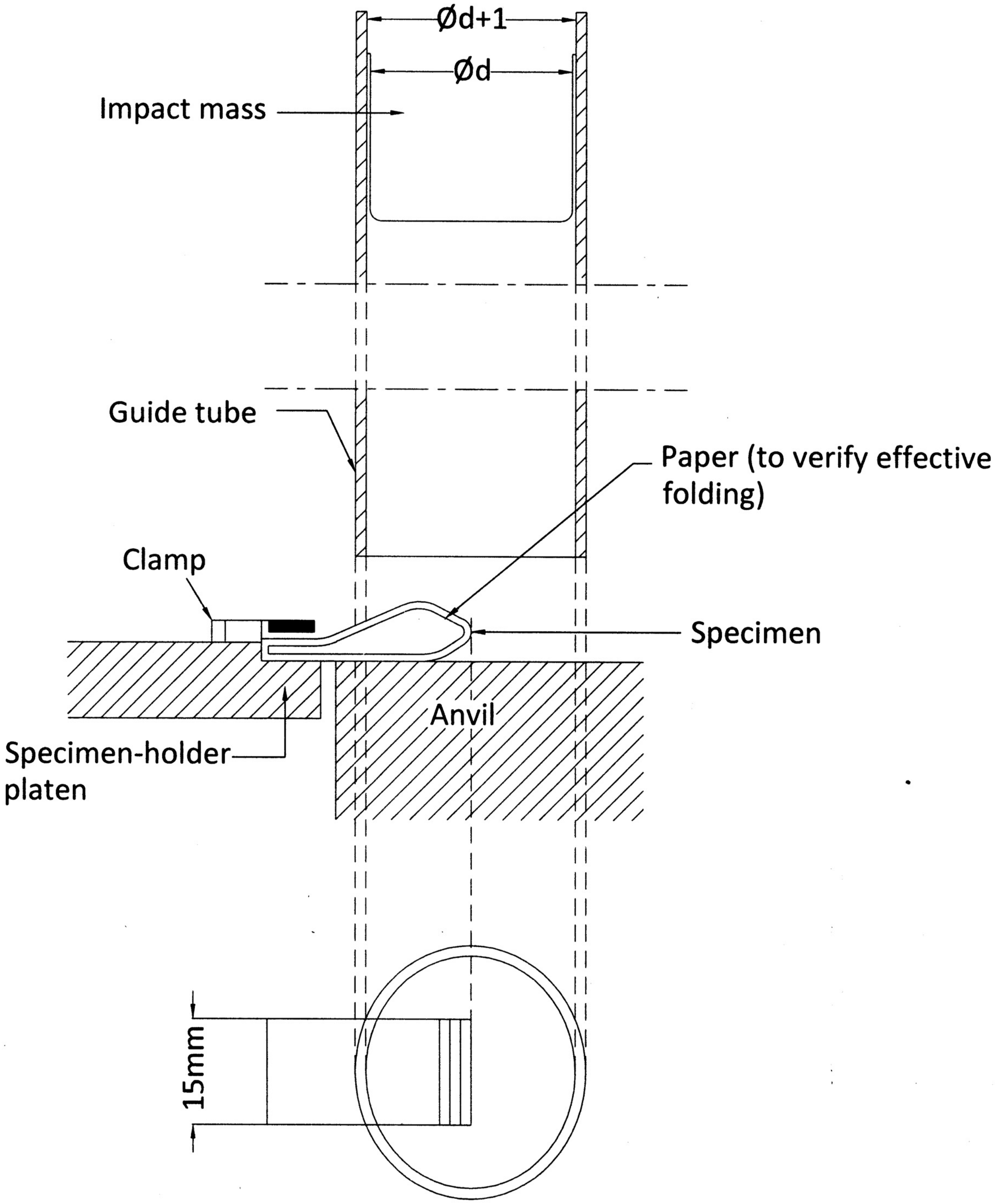
Ød+1
Ød
Impact mass
Guide tube
Paper (to verify effective folding)
Clamp
Specimen
Anvil
Specimen-holder platen
15mm

FIG. 3

E-2.1.5 *Holding Device*, to align the platen and the guide tube in such a position that the centre of the impact mass coincides with the edge of the flattened loop (20 mm from the clamp).

E-2.2 Cooling Chamber, to house the impact device allowing the temperature to be lowered in steps of 1°C, and able to maintain a temperature constant to within ±1°C.

E-2.3 Thermometer, graduated in 0.5°C, or thermocouple, with an accuracy of 0.5°C, placed in the cooling chamber in the proximity of the specimens.

E-3 SPECIMENS

E-3.1 Shape and Dimensions

The specimens shall consist of strips measuring 60 mm × 15 mm. Their edges shall be free from cuts, scratches and other imperfections.

E-3.2 Number of specimens

5 specimens shall be taken with their long axis (60 mm) parallel to the machine (that is longitudinal) direction, and 5 specimens with their long axis parallel to the transverse direction.

E-4 ATMOSPHERIC CONDITIONS FOR CONDITIONING AND TESTING

Condition the test specimens to moisture equilibrium from the dry side in the standard atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C temperature (*see also* IS 6359). When the specimens have been left in such an atmosphere so that both the faces are exposed to the standard atmosphere as far as possible for 24 h, they shall be deemed to have reached the state of moisture equilibrium.

E-5 PROCEDURE

E-5.1 Verify the alignment of the guide tube with respect to the position of the specimen on the platen.

E-5.2 Place the impact device containing the mounted specimens in the cooling chamber. When the impact device has reached equilibrium at the test temperature of –5°C (approximately 15 min), position the specimen below the guide tube. Release the impact mass, then reset it to its initial position. Repeat the operation for the other specimens, if any.

Take the platen out of the cooling chamber, remove the specimens and inspect them.

A specimen is deemed to be damaged or broken, if any trace of breaking is visible to the naked eye. This trace can be a point or a line, while total rupture may occur, with or without splintering. A whitish line at the fold may occur with certain types of pigmented or un-pigmented material, but this is not considered as a failure.

ANNEX F

(*Foreword*)

COMMITTEE COMPOSITION

Technical Textiles for Agro-tech Sectional Committee, TXD 35

Organization	*Representative*(*s*)
The Synthetic & Art Silk Mills Research Association, Mumbai	Dr U. K. Gangopadhyay (***Chairman***)
Business Co-ordination House Pvt Ltd, New Delhi	Shri Samir Gupta Shrimati Ritika Gupta (*Alternate*)
Central Institute for Research on Cotton Technology, Mumbai	Dr S. K. Chattopadhyay Dr R. Guruprasad (*Alternate*)
Central Institute of Plastics Engineering & Technology (CIPET), Bhopal	Shri P. K. Sahoo Dr. Ajay Kumar Neema (*Alternate*)
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Indian Technical Textile Association, Mumbai	Shrimati Shashi Singh Ms. Priyanka Prajapati (*Alternate*)
Lamifab & Paper (P) Ltd, Aurangabad	Shri Kamleish Dhoot Shri Kishori Lal Dhoot (*Alternate*)
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National Horticultural Board, Gurgaon	Representative
National Jute Board, Kolkatta	Shri Tapobrata Sanyal Shri Alok Kumar Khastagir
Navsari Agricultural University, Navsari,	Dr V. Kumar Dr R. G. Patil (*Alternate*)
Neo corp International Limited, Pithampur	Shri Sunil Kumar Trivedi Shri Ashok Kumar Gupta (*Alternate*)
Office of the Textile Commissioner, Mumbai	Shri M. Baluchamy Shri J. Ahmed (*Alternate*)
Punjab Agricultural University, Ludhiana	Dr Rakesh Sharda
Reliance Industries Ltd, New Delhi	Shri M. S. Verma Shri Shrichand Santani (*Alternate*)
Shri Ambica Polymer Pvt. Ltd, Ahmedabad	Shrimati Jyotika Nagri Mrs. Anuja Malviya (*Alternate*)
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The Bombay Textile Research Association, Mumbai	Shri V. K. Patil Shri C. H. Sakharkar (*Alternate*)

Organization	*Representative(s)*
The Synthetic & Art Silk Mills Research Association, Mumbai	Dr Manisha Mathur Shri P. R. Survase (*Alternate*)
BIS Directorate General	Shri Prabhakar Rai, Scientist 'E' and Head (TXD) [Representing Director General (*Ex-officio*)]

Member Secretary
Shri J. K. Gupta
Scientist 'C' (TXD), BIS

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.org.in

Regional Offices:		*Telephones*
Central	Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	2323 7617 2323 3841
Eastern	1/14 C.I.T. Scheme VII M, V. I. P. Road, Kankurgachi KOLKATA 700054	2337 8499, 2337 8561 2337 8626, 2337 9120
Northern	SCO 335-336, Sector 34-A, CHANDIGARH 160022	260 3843 260 9285
Southern	C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442 2254 2519, 2254 2315
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